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## **Improving Flood Protection**

### **Understanding How Levees Are Different From Dams**

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## **Presentation Outline**

- **Introduction**
- **Dam Safety**
- **Levees and Hurricane Katrina**
- **Differences Between Levees and Dams**
- **Paths for the Future**

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## Introduction

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Early Dam Failures lead  
to Dam Safety Policies  
and Agencies

1928 St. Francis Dam Failure

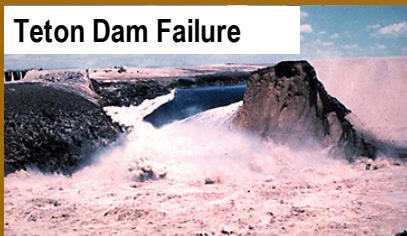


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## Recent Dam Failures

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Teton Dam Failure



December 14, 1963	Baldwin Hills Dam and Reservoir, CA	5 dead
February 26, 1972	Buffalo Creek Tailings Dam, WV	125 dead
June 9, 1972	Canyon Lake Dam, SD	~238 dead
June 5, 1976	Teton Dam, ID	11 dead
July 19-20, 1977	Laurel Run Dams, PA	40 dead
November 5, 1977	Kelly Barnes Dam, GA	39 dead

Total ~ 500 dead

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## 1971 Near Failure of Lower San Fernando Dam

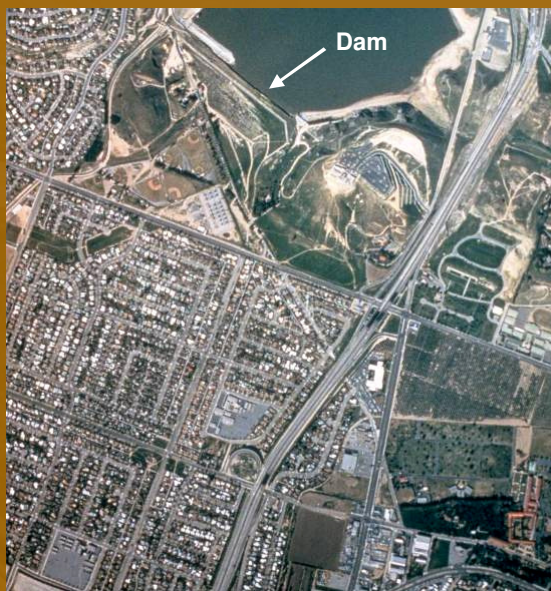
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## 1971 Near Failure of Lower San Fernando Dam

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**80,000 people  
resided in the  
inundation area  
downstream of  
the dam**

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## Dam Safety

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- ✓ **Primary Responsibility Lies with the States**
  - 95% of dams regulated by the States
- ✓ **FERC Also Regulates Dams Providing Power**
- ✓ **Federal Government Provides Some Financial Assistance**
- ✓ **FEMA Coordinates Federal Assistance**

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## Levees and Hurricane Katrina

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**17<sup>th</sup> Street Canal  
Floodwall Failure**

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## Levees and Hurricane Katrina

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## Levees and Hurricane Katrina

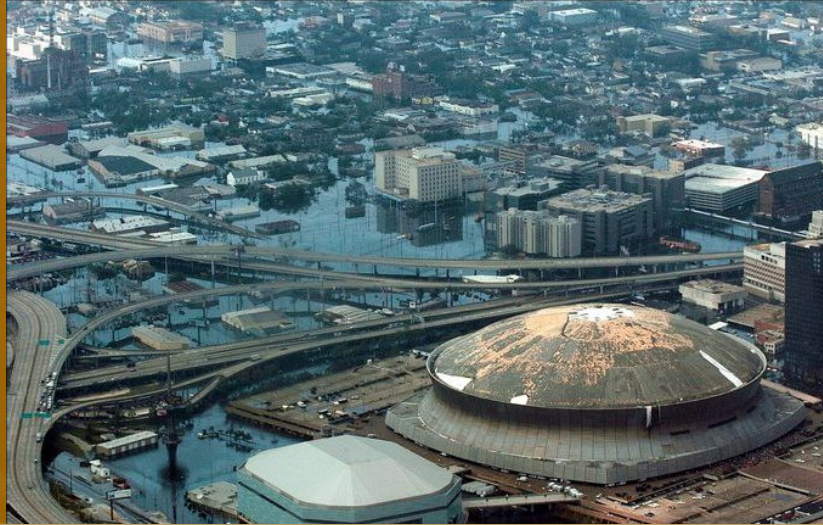
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## Levees and Hurricane Katrina

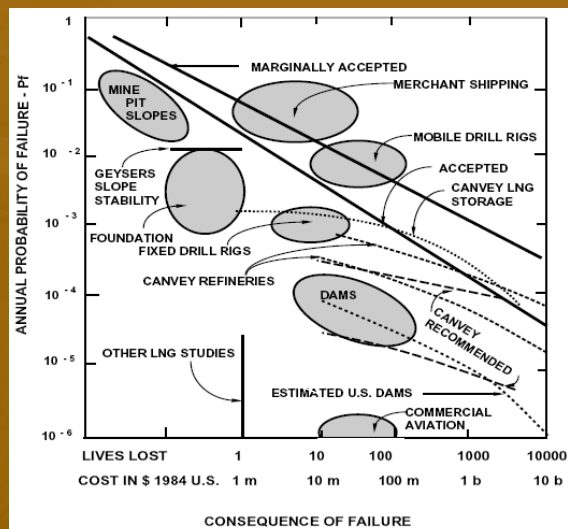
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## Levees and Hurricane Katrina

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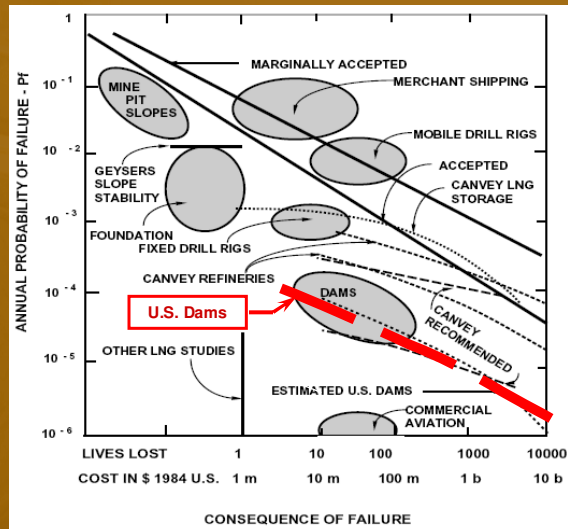
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from Christian (2004)



## Levees and Hurricane Katrina

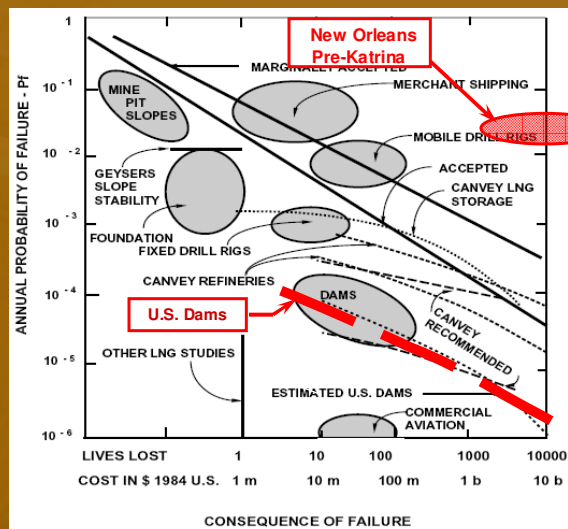
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## Levees and Hurricane Katrina

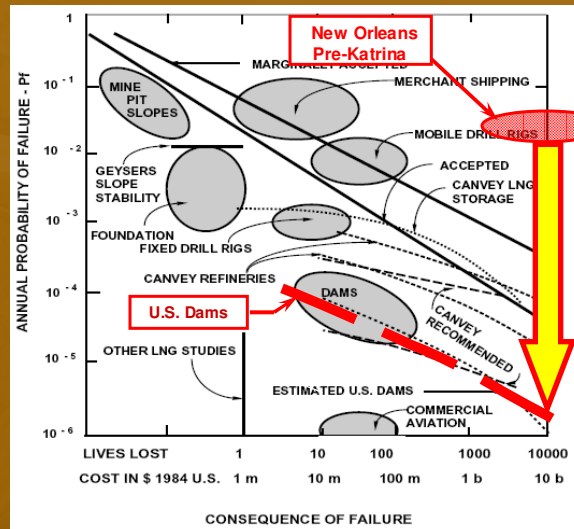
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## Levees and Hurricane Katrina

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## Just How Many Levees Are There in the United States?

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- No accurate inventory currently exists
- There are 14,000 miles of levees inventoried in California
  - of which, only about 2,000 miles were completed by the Corps of Engineers
- Extrapolating from California's inventory, there are probably between 100,000 to 300,000 miles of levees in the nation



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## Improving Flood Protection

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**Levees are not Dams!**



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## Improving Flood Protection

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**Differences Between Levees and Dams:**

- |                               |                                      |
|-------------------------------|--------------------------------------|
| ● Ownership                   | ● Foundation Characterization        |
| ● Purpose and Benefits        | ● Structural Composition             |
| ● Imposition of Flood Risk    | ● Environmental Impacts              |
| ● Structural River Footprint  | ● Performance Instrumentation        |
| ● Height                      | ● Regulatory Measures to Reduce Risk |
| ● Duration of Water Retention | ● Improvements and Transfer of Risk  |
| ● Age                         | ● Space for Structural Upgrades      |
| ● Siting                      | ● Performance Expectations           |
| ● Design Criteria             |                                      |

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## Improving Flood Protection

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### Differences Between Levees and Dams:

- **Ownership**
- Purpose and Benefits
- Imposition of Flood Risk
- **Structural River Footprint**
- Height
- Duration of Water Retention
- Age
- Siting
- Design Criteria
- Foundation Characterization
- Structural Composition
- Environmental Impacts
- Performance Instrumentation
- **Regulatory Measures to Reduce Risk**
- **Improvements and Transfer of Risk**
- Space for Structural Upgrades
- **Performance Expectations**

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## Differences Between Levees and Dams

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### Ownership



Ownership of Levees Often  
Unclear

Agencies with Overlapping  
Responsibilities

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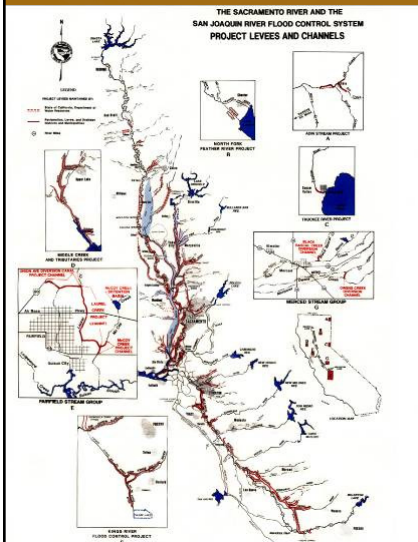


Dams generally have clear  
ownership

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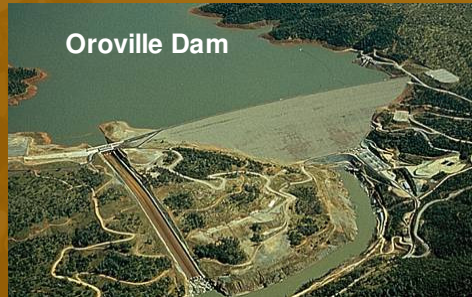
## Differences Between Levees and Dams

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### Structural Footprint

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Dams have limited footprint  
across/along river system

Levee systems often run for hundreds of miles

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## Differences Between Levees and Dams

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### Structural Footprint



Levee systems commonly share same space as water  
conveyance, critical habitat, and urban esthetics and recreation

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## Differences Between Levees and Dams

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### Duration of Water Retention



Levees are only part-time workers – retain water for only limited periods (e.g. weeks) during flood events



Dams commonly store water year round

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## Differences Between Levees and Dams

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### Age



Most levees are legacy systems  
- up to 150 years old

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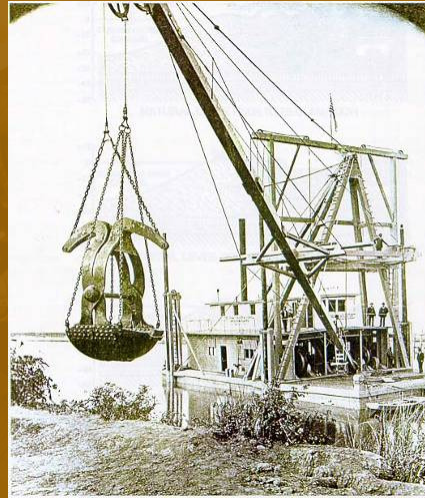
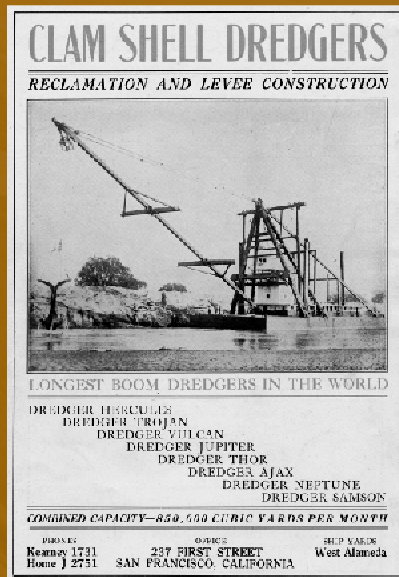


Majority of Dams  
constructed since 1950's  
with modern methods

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## Age – Levees are legacy systems

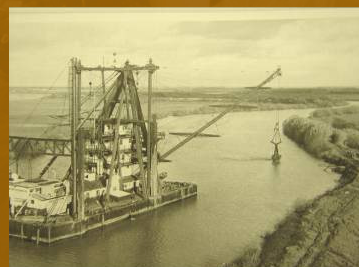
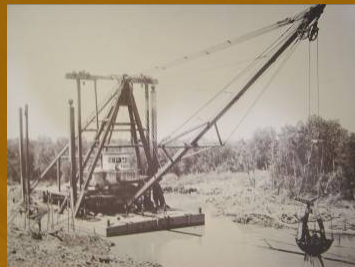
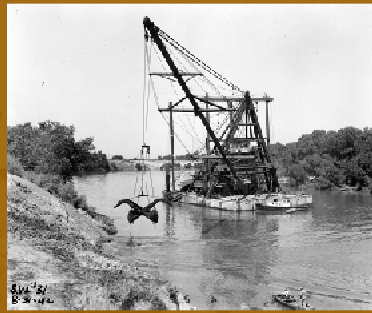
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## Age – Levees are legacy systems

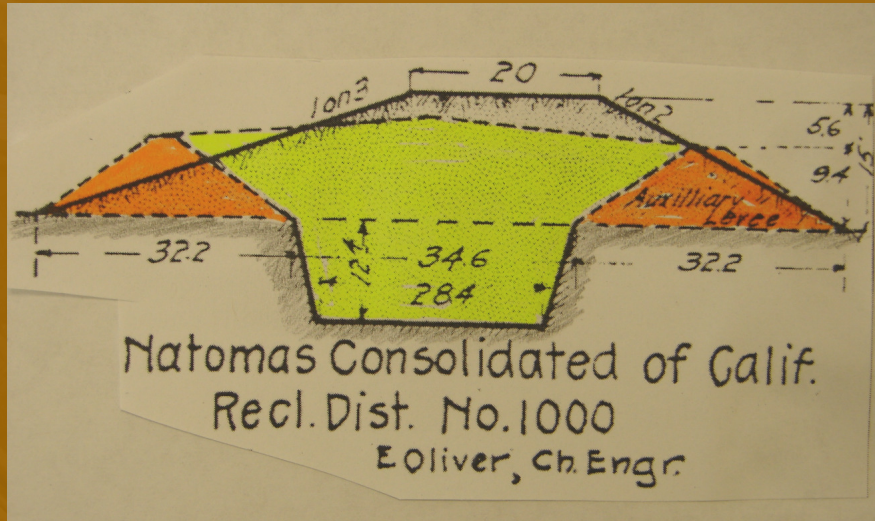
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## Age – Levees are legacy systems

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## Age – Levees are legacy systems

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Placement of Hydraulic Fill for Natomas Levee

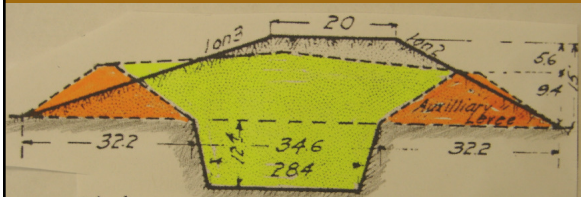


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## Age – Levees are legacy systems

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## Age – Levees are legacy systems

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Natomas – Sacramento River East Levee – February 1986



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### Regulatory Measures to Reduce Risk



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Cannot restrict river systems –  
no real regulation of levees -  
limited abilities to restrict future  
development

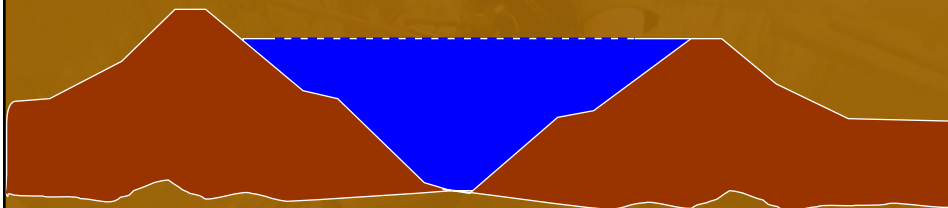
Restrict reservoir if dam does not  
meet high standards of safety

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### Levee Improvements and Transfer of Risk



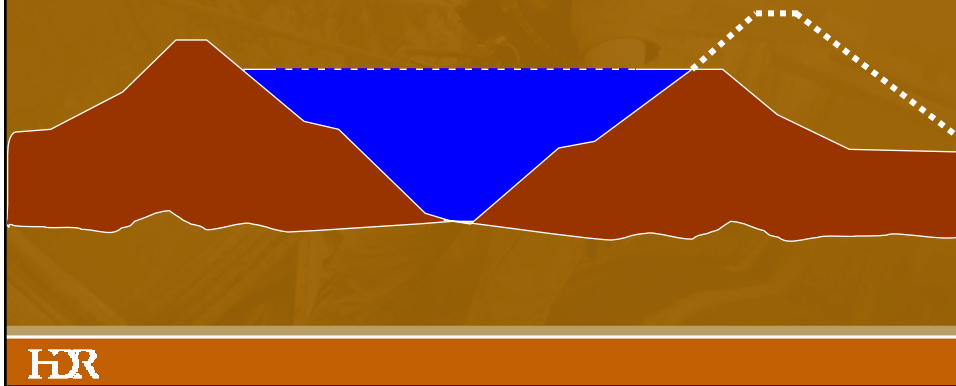
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### Levee Improvements and Transfer of Risk

Planned Levee Raise

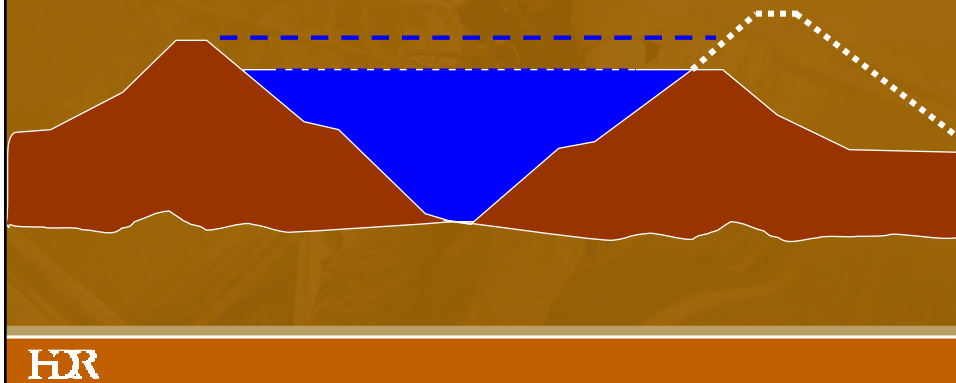


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### Levee Improvements and Transfer of Risk

Planned Levee Raise

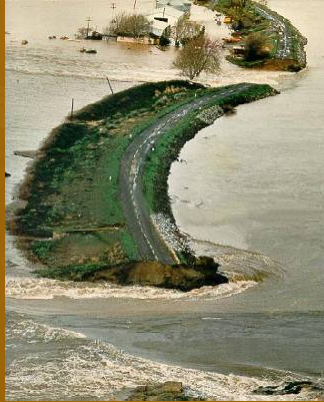




## Differences Between Levees and Dams

### Performance Expectations

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We cannot rely on levees to perform well during even minor floods

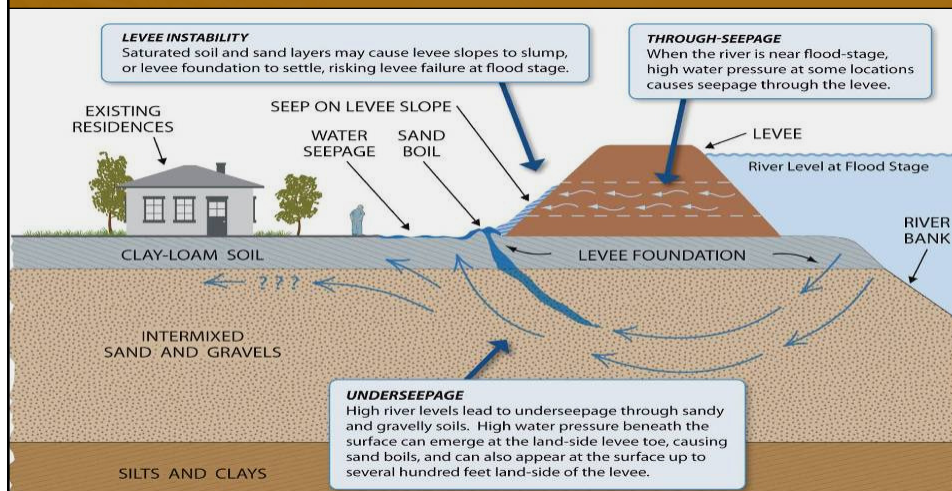
We expect dams to perform well for routine loadings, and to be safe for even extreme events

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## Differences Between Levees and Dams

### Performance Expectations

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## Differences Between Levees and Dams

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Performance Expectations:

Levees Require Flood-Fights to Survive Even Minor Floods



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## Differences Between Levees and Dams

Performance Expectations: Levees Fail!

California's State Engineer, William Hammond Hall, reportedly stated:

*"...There are two kinds of levees, those that have failed and those that will fail."*



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## Paths for the Future

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### Recognize that:

- Levees are not Dams
- There are huge numbers of levees
- Levees are legacy structures – old and substandard
- We do not have policies or institutional systems to appropriately govern or fund levee improvements - ***We are not where we want to be!***

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## Paths for the Future

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### Tentative Guiding Principles:

1. Recognize that reducing flood risks will have to be a sustained continuous effort over time

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## Improved Flood Walls at NOLA Industrial Canal

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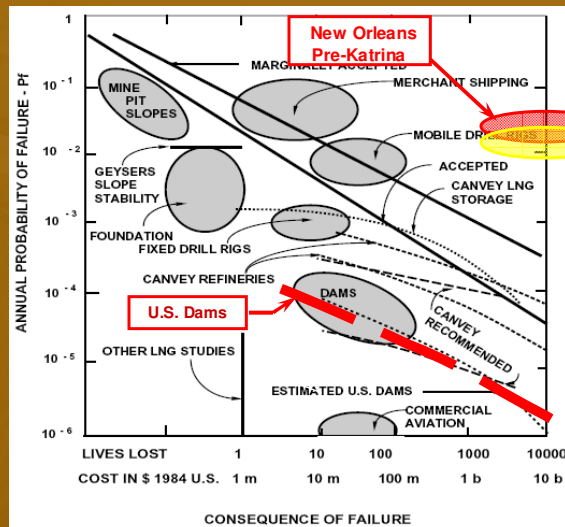
### Wave/Water Loading During Hurricane Gustav



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## Levees and Hurricane Katrina

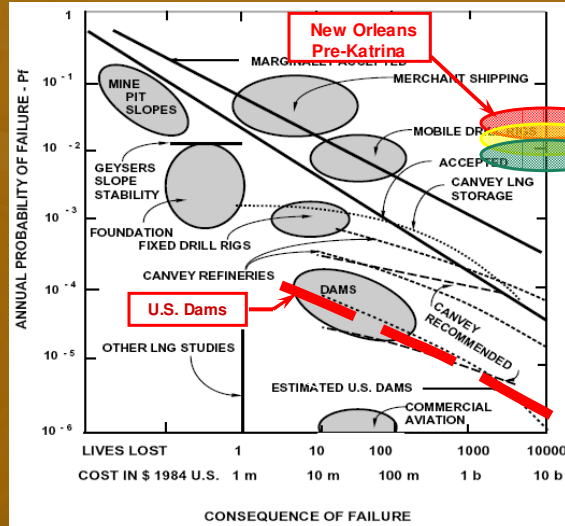
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# Levees and Hurricane Katrina

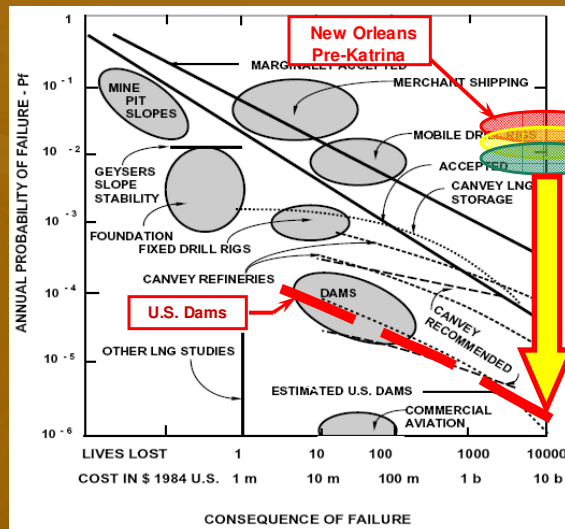
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# Levees and Hurricane Katrina

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### Tentative Guiding Principles:

2. Recognize that risks increase as we put more people in the floodplain



$$\text{Flood Risk} = \text{Probability of Flooding} \times \text{Consequences of Flooding}$$

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## Paths for the Future

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### Tentative Guiding Principles:

3. Acknowledge that levees share the same space as critical habitat – and that environmental stewardship needs to be a high priority along with flood risk reduction

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## Paths for the Future

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### Tentative Guiding Principles:

4. Obtain the highest risk reduction with limited resources

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## Paths for the Future

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### Tentative Guiding Principles:

5. Develop strategies for long-term system improvements over generations

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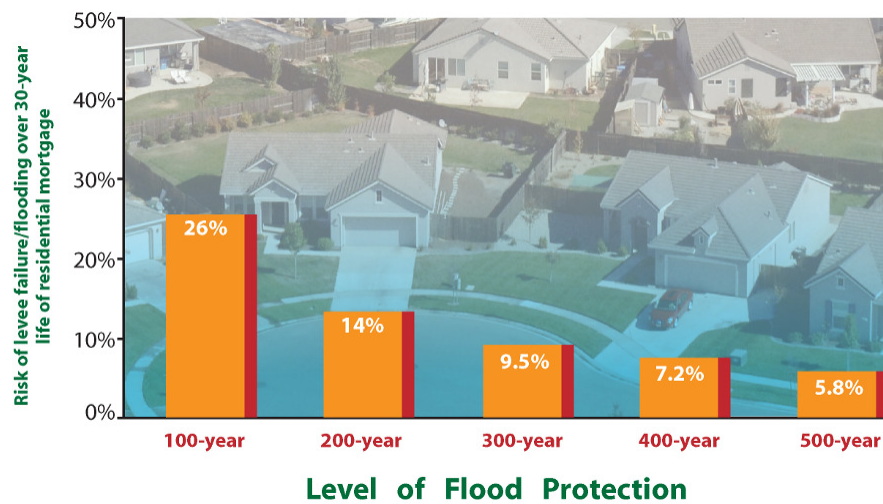
### Tentative Guiding Principles:

6. Use non-structural measures such as notification, flood insurance, land use planning, and emergency preparation measures to reduce risk

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## Risk Communication and Notification

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(from DWR, 2008)

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### Tentative Guiding Principles:

7. Apply flexible approaches that can be adapted to maximize flood risk reduction for specific communities

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### Post-Katrina Elevation of Homes in Terrebonne Parish

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Thank you

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